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IMPACT OF FERMENTED PALM KERNEL MEAL ON BROILER GROWTH AND HEALTH PARAMETERS

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Abstract

The main objective of this research was to determine how Fermented Palm Kernel Meal and Raw Palm Kernel Meal affected the rate of growth, hematological and biochemical indices of broilers chicken. A total of 180 one-day-old chicks were divided into three treatments, each of which contain six replicates of ten birds. Control diet served as the foundation of the experimental diets. The trial spanned a total duration of 42 days. The aim of investigation three groups was allotted as Control (CONT), Raw Palm Kernel Meal (RPKM) AND Fermented Palm Kernel Meal (FPKM). Results show that FPKM group significantly ($P<0.05$) improved live body weight (LBW), Feed Intake (FI) and feed conservation ratio (FCR) than RPKM. The FPKM group exhibited a significantly ($P<0.05$) higher red blood cells (RBCs), and hemoglobin (Hb) levels compared to RPKM. Whereas no significant changes were seen in white blood cells (WBCs). Biochemical analysis revealed that Total Protein (TP), Globulin (GLB), Glucose (GLU) levels significantly ($P<0.05$) improved in FPKM. While LDL, HDL and Albuminremain unaffected among all groups. Cholesterol were significantly ($P>0.05$) decreased in FPKM than RPKM. According to this study, broiler chickens could receive up to 15% of their diets consisting of fermented palm kernel meal without having any negative effects on their hematological, biochemistry, or growth performance.

Keyword: Fermented Palm Kernel Meal (FPKM), Growth Performance, Hematological Indices, Biochemical Indices

INTRODUCTION

The global population is expected to rise from 7.7 billion in 2018 to nearly 10 billion by 2050, leading to an increasing demand for animal protein sources. To meet this growing demand, poultry meat production has significantly expanded, increasing from 9 million tons in 1961 to 122 million tons in 2017, with an anticipated annual growth rate of 2.4% between 2015 and 2030 (FAO, 2017). The broiler industry, an essential part of the poultry sector, plays a vital role in meeting the protein needs of the population. In Pakistan, this sector is particularly significant but faces several nutritional challenges. Addressing these challenges is crucial for ensuring the growth, health, and productivity of broilers and sustaining the industry's growth and viability.

Over the past 50 years, advancements in poultry production standards have made it one of the most successful sectors, with male broilers reaching a market weight of 2.5 kg within 6-7 weeks of age (Ravindran, 2012). This rapid growth has increased the demand for feed and raw materials (Ravindran & Son, 2011). Feed costs account for approximately 65-75% of the total expenses in broiler production, emphasizing the importance of optimizing feed quality and formulation (Mahmood et al., 2005; Daghir, 2008; Glatz, 2012; Sittiya and Yamauchi, 2014; Diarra, 2015; Hossain et al., 2015). Various dietary energy levels affect nutrient digestion rates, impacting broiler growth and development (Cho et al., 2013).

Due to high costs associated with traditional feed ingredients like maize and soybeans, which make up around 70% of energy feedstuff costs in poultry diets, alternative feed sources have been explored to reduce expenses. However, many alternative feeds have challenges, such as low digestibility and anti-nutritional factors that hinder nutrient utilization. Palm kernel meal (PKM), a by-product of oil extraction from palm nuts, has been considered as a potential feed ingredient for broilers. PKM contains about 18% crude protein and 20% crude fiber, with β-mannan being the main component of its non-starch polysaccharides (NSPs). The NSPs in PKM have prebiotic effects linked to mannose and manno-oligosaccharides. Studies have shown that PKM, when included in broiler diets up to 40%, does not exhibit anti-nutritional properties and can improve immune function, reduce harmful bacteria, and promote beneficial bacteria growth (Azizi et al., 2021; Sundu et al., 2006).

Fermentation is a promising approach in animal nutrition to overcome the anti-nutritional factors present in feed ingredients. Many feed materials, like grains and oilseed meals, contain anti-nutritional elements that affect nutrient utilization. Fermentation, the process by which complex compounds are broken down by beneficial microorganisms, improves the nutritional value and bioavailability of essential nutrients (Parmar et al., 2019). Solid-state fermentation (SSF), where microorganisms grow on a solid substrate with minimal water, has been effective in breaking down complex materials into simpler, more digestible forms (Murty et al., 2018). Fermentation is particularly beneficial in degrading anti-nutritional factors like phytates, tannins, and protease inhibitors, which otherwise chelate minerals and prevent their absorption in the digestive tract (Selle & Ravindran, 2007). Despite the potential benefits, there is limited research on the nutritional effects of PKM feeding on broilers in Pakistan. Investigating the substitution of conventional ingredients with PKM in broiler diets may offer insights into improving growth performance and feed efficiency. Therefore, this study aims to evaluate the growth performance, hematology, and blood biochemical indices of broilers fed with PKM, providing a better understanding of its nutritional value and potential use in Poultry diets.

MATERIALS AND METHODS

Housing Management

The study was conducted at the Poultry Experimental Station of the Faculty of Animal Husbandry & Veterinary Sciences, Department of Poultry, Sindh Agriculture University, Tandojam, using 180 day-old Cobb chicks. Before the chicks' arrival, rigorous sanitation was performed, including washing the shed with water and spraying lime to eliminate any bacteria. The experimental room was then prepared with dried-out wood shavings and set up brooders to maintain the appropriate temperature. Initially, the house temperature was set at 32°C for the first week, followed by a gradual decrease of 2°C per week until it reached 22°C. Humidity levels were maintained between 55% and 65% throughout the experiment. Water and feed were provided ad libitum, and lighting was maintained for 24 hours a day. Regular health checks were conducted, and vaccinations were administered according to the Pakistan Poultry Association (PPA) guidelines.

Dietary Treatments

The chicks were weighed initially and then divided into three groups, each with six replicates of ten chicks. The experiment lasted for 42 days, divided into two phases: the starter phase (days 1-21) and the finisher phase (days 22-42). Bedding material, consisting of litter and newspaper, was provided for each group, with the newspaper being used only until day three. During the experiment, temperature control and humidity management were strictly maintained, as described in the housing management section. Feed and water were accessible at all times.

Treatment	Description
T1	Basal diet control group
T2	Basal diet + 15% Raw Palm Kernel Meal
T3	Basal diet + 15% Fermented Palm Kernel Meal

Production of Fermented Palm Kernel Meal

Palm kernel meal (PKM) was procured from the local market in Hyderabad, Sindh, Pakistan, and fermented using Bacillus pumilus at a concentration of 2.0 x 10^{11} via solid-state fermentation (Alshelmani et al., 2014). To prepare the fermented PKM, distilled water was added to achieve a moisture ratio of 1:0.8 (w/v). A 6.66% (v/w) inoculum of Bacillus pumilus was mixed with 30 kg of PKM and 16.5 liters of water, stirred for 15 minutes, and then incubated at 30°C for 48 hours. The fermented PKM was subsequently autoclaved and dried before being used as feed for the broilers. The supply of Bacillus pumilus was provided by Jinan Rentai Pvt. Ltd., China.

Feed Analysis

The proximate analysis of the feed samples was conducted to determine the dry matter, crude protein, crude fat, and ash content according to the procedures outlined by the Association of Official Analytical Chemists (AOAC, 2005).

Growth Performance

To assess growth performance, feed was withdrawn six hours before weighing the broilers. Weights were recorded on day 42. The live body weight (LWB) and feed intake were measured, and the feed conversion ratio (FCR) was calculated using the formulas:

Feed intake = (Total feed offered – Total feed refused) / Total broilers
FCR = Feed intake / Weight gain
Blood Biochemistry and Hematology

Sample Collection

On the final day of the experiment, 5 ml of blood was collected from the wing vein of each bird and placed in a vacutainer containing EDTA as an anticoagulant to prevent clotting. Hemoglobin (Hb), red blood cells (RBC), and white blood cells (WBC) counts were analyzed using an automated hematological analyzer (Model BIOCELL-86, Biogen GmbH, Berlin, Germany). Another 5 ml of blood was centrifuged at 2500 rpm for 15 minutes at 4°C to collect serum, which was then stored at -20°C for further analysis. A fully automated biochemical analyzer (Model SMT-120V, Quadratic Diagnostics Ltd., East Sussex, UK) was used to determine total protein (TP), albumin (ALB), globulin (GLB), glucose (GLU), total cholesterol (TC), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels.

Statistical Design

Data were statistically analyzed using SPSS Statistics 19.0 with an Analysis of Variance (ANOVA) to determine significant differences among treatment means. Duncan's new multiple-range test was applied for post-hoc comparisons of means, and the results were presented as means ± standard error.

RESULTS

Live Body Weight

Figure 4.1 illustrates the effect of palm kernel meal inclusion in broiler chicken feed on live body weight. Statistical analysis indicates that the FPKM group had a significantly higher live body weight (P<0.05) compared to the RPKM group. However, there was no significant difference in live body weight between the CONT and FPKM groups.

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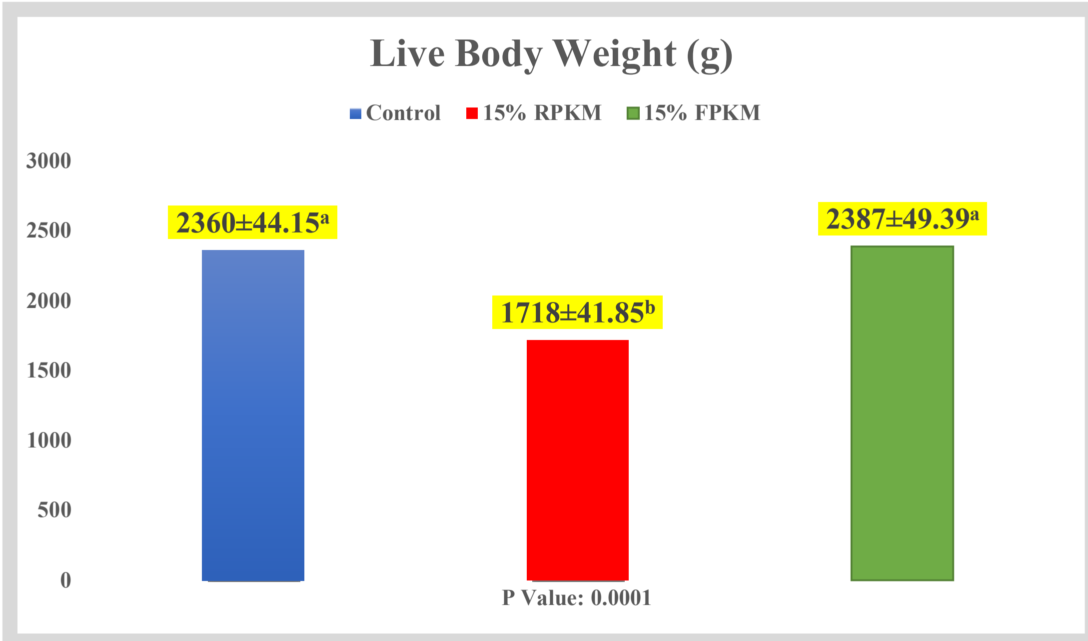
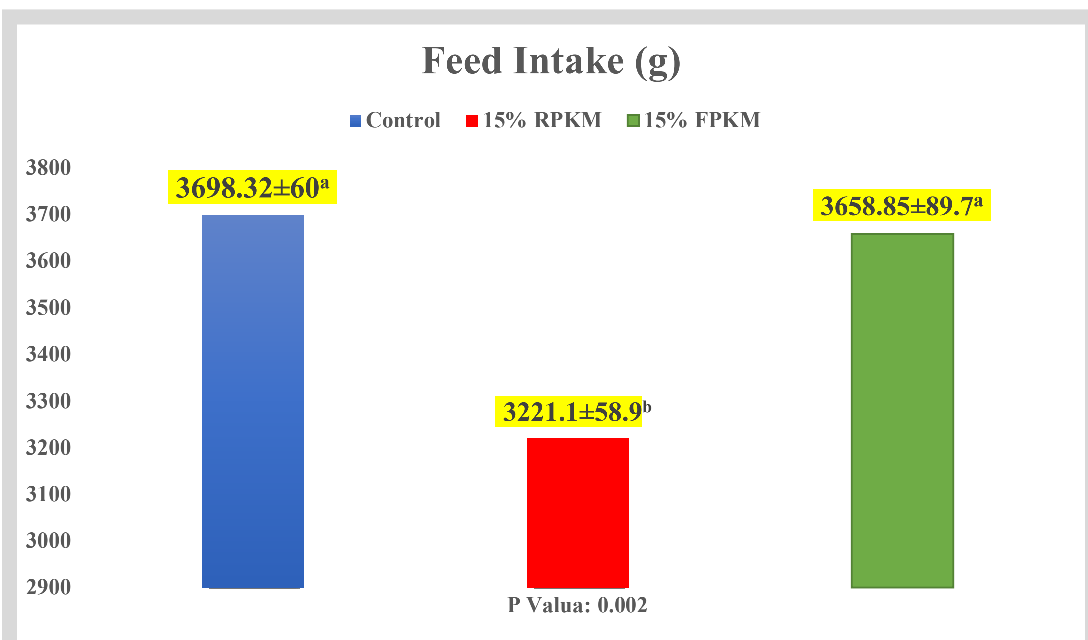


*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.1 Effect of palm kernel meal on live body weight of broiler chickens.

Feed Intake

The impact of palm kernel meal on feed intake in broiler chickens is depicted in Figure 4.2. The analysis of variance (ANOVA) revealed a significantly higher feed intake ($P<0.05$) in the FPKM group compared to the RPKM group. However, there was no significant difference in feed intake between the CONT and FPKM groups. The lowest feed intake was recorded in the RPKM group



*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.2 Effect of palm kernel meal on feed intake of broiler chickens.

Feed Conversion Ratio

Figure 4.3 illustrates the effect of palm kernel meal on the Feed Conversion Ratio (FCR) of broiler chickens. The FCR improved

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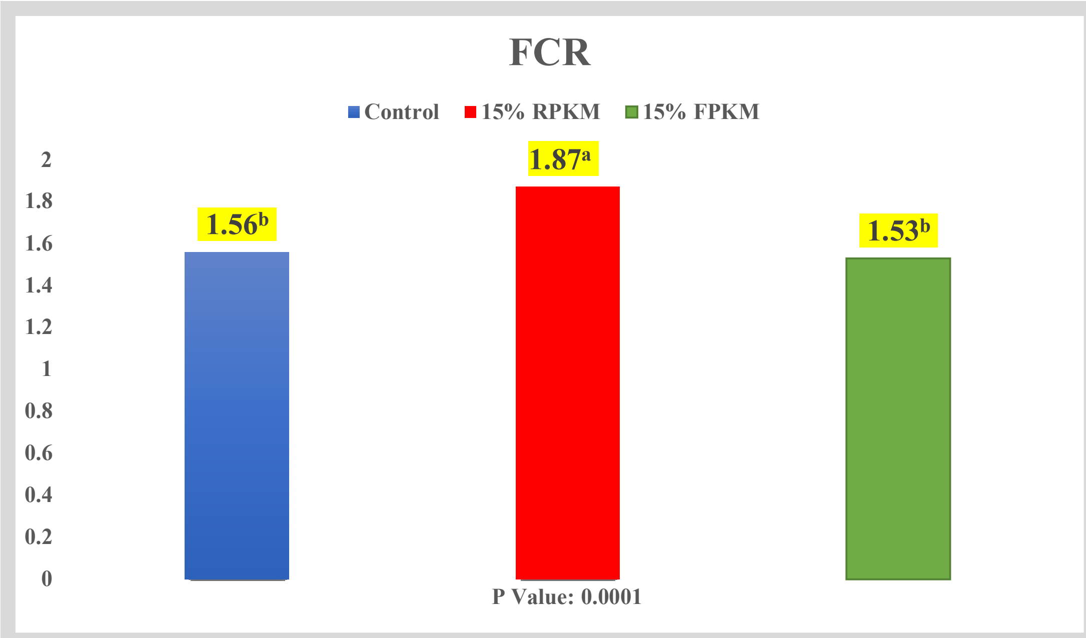
significantly (P<0.05) in broilers fed with 15% FPKM compared to those fed with 15% RPKM, indicating its better efficacy as a feed component.



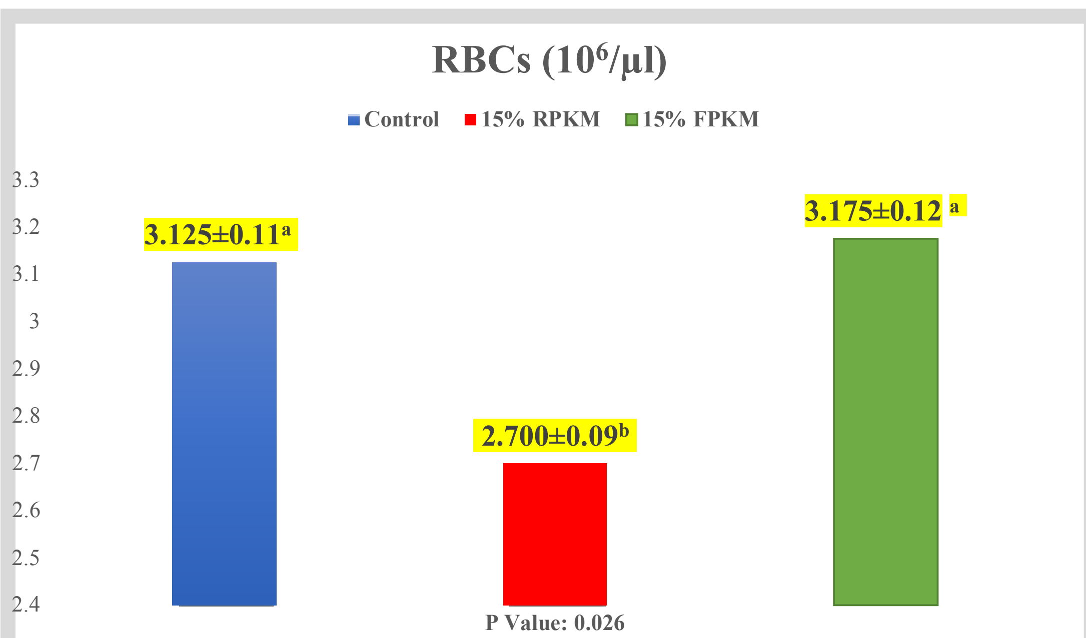
*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.3 Effect of palm kernel meal on feed conversion ratio of broiler chickens.

HEMATOLOGY PARAMETERS

Red Blood Cells

Figure 4.4 shows the effect of palm kernel meal on the red blood cell (RBC) count of broiler chickens. A significantly higher RBC count (P<0.05) was observed in broilers fed 15% FPKM compared to those fed 15% RPKM. No significant difference was noted between the CONT and RPKM groups.



*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.4 Effect of palm kernel meal on red blood cells of broiler chickens.

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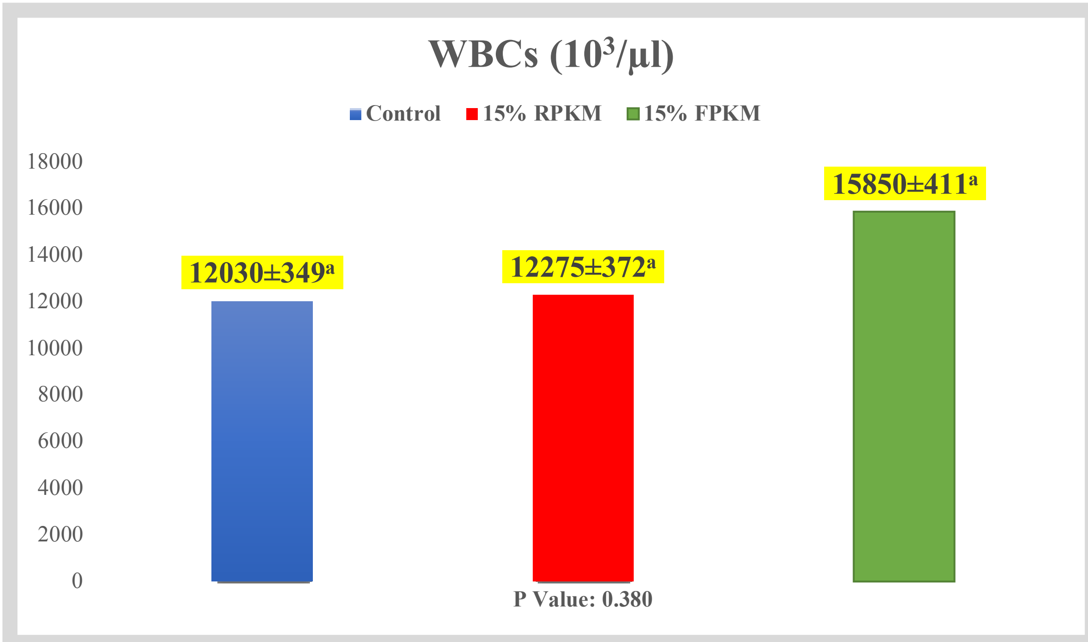
White Blood Cells

Figure 4.5 illustrates the effect of palm kernel meal on the white blood cell (WBC) count of broiler chickens. There were no significant differences (P<0.05) in the WBC count across all groups, including those fed 15% FPKM, 15% RPKM, or the CONT group.

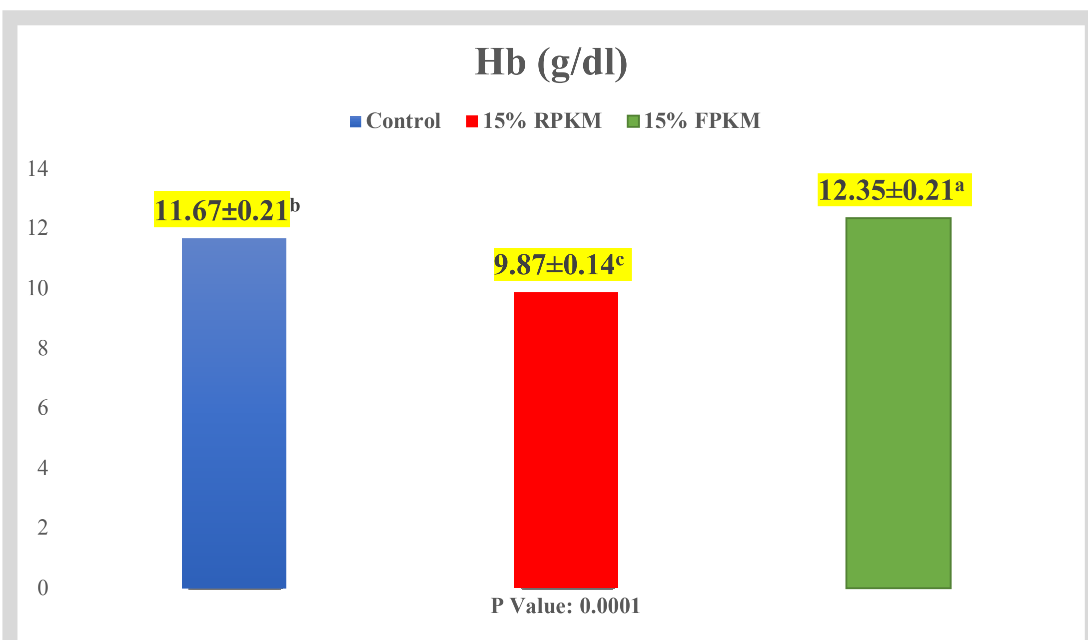


*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.5 Effect of palm kernel meal on white blood cells of broiler chickens.

Haemoglobin

Figure 4.6 presents the results of haemoglobin levels. A significantly higher level of haemoglobin (P<0.05) was recorded in the FPKM group compared to the other groups, whereas the lowest level was observed in the RPKM group.



*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Figure 4.6 Effect of palm kernel meal on hemoglobin of broiler chickens.

Effect of Fermented Palm Kernel Meal on Biochemical Indices

The results presented in Table 4.3 show that Total Protein (TP), Globulin (GLB), and Glucose (GLU) levels were

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significantly higher (P<0.05) in the FPKM group compared to the RPKM group. Meanwhile, LDL, HDL, and Albumin levels remained unaffected across all groups. However, cholesterol levels were significantly reduced (P<0.05) in the FPKM group compared to the RPKM group, with no significant difference observed between the CONT and FPKM groups. These findings suggest that a fermented PKM diet could be beneficial for broilers in terms of improving certain biochemical parameters.

Parameters	Treatments			P.value
	CONT	RPKM 15%	FPKM 15%	
Total Protein g/Dl	**7.770±0.18^{a}**	**5.75±0.17^{b}**	**8.05±0.22^{a}**	0.0001
Albumin g/dL	**2.722±0.04^{a}**	**2.325±0.23^{a}**	**2.812±0.07^{a}**	0.096
Globulin g/dL	**5.04±0.14^{a}**	**3.42±0.12^{b}**	**5.23±0.27^{a}**	0.0001
Glucose mg/dL	**176.25±2.72^{a}**	**145.75±2.49^{b}**	**177.25±3.03^{a}**	0.030
LDL mg/dL	**64.25±3.01^{a}**	**72.25±1.10^{a}**	**66.00±3.02^{a}**	0.119
HDL mg/dL	**44.50±1.70^{a}**	**40.25±1.65^{a}**	**42.25±2.28^{a}**	0.333
Cholesterol mg/dL	**170.25±3.47^{ab}**	**182.00±5.35^{a}**	**115.25±3.25^{b}**	0.069

*Control= Basal Diet; 15 RPKM= 15% Raw Palm Kernel Meal; 15 FPKM=15% FermentedPalm Kernel Meal

Table 4.1 Effect of Fermented Palm Kernel Meal Biochemical Indices on broilerchicken.

DISCUSSIONS

The global demand for food is at an all-time high, placing immense pressure on the poultry industry to produce meat efficiently in an increasingly competitive market. The poultry feed industry relies heavily on imported ingredients like soybean, a vital source of plant-based protein. Soybean meal, widely considered the safest and most effective plant-based protein, is extensively used in poultry feed. However, disruptions in soybean imports can lead to shortages, creating challenges for the industry. In response, this study explores alternative plant-based protein sources, focusing on Palm Kernel Meal (PKM) as a viable substitute.

As noted by Sundu et al. (2006), PKM offers several benefits, including improved bird immunity, reduced pathogenic bacteria, and increased beneficial bacteria for gut health. Additionally, Fernandez et al. (2000, 2002) highlighted the role of β-mannan in PKM as a prebiotic that enhances immune function. Due to the low protein content of raw PKM, fermentation is utilised to enhance its protein levels. According to Alshelmani et al. (2021), fermented PKM (FPKM) can be incorporated into broiler feed as a partial replacement for soybeans and yellow corn, improving its nutritional value and reducing costs.

Various methods, such as soaking, extrusion, enzyme addition, or solid-state fermentation (SSF), can further enhance the nutritional value of PKM. Future research should consider combining these methods to develop an optimised PKM diet (Alshelmani et al., 2021).

Growth performance is crucial in broiler production, as a more efficient feed-to-weight ratio reduces costs. Studies have shown that heat stress can negatively affect growth and carcass characteristics (Lu, 2018). Our study found that fermented PKM significantly improved the feed conversion ratio (FCR), live body weight (LBW), and feed intake (FI) compared to raw PKM. Alshelmani et al. (2021) support our findings, suggesting that 15% FPKM can partially replace soybeans and yellow corn in broiler feed, thereby reducing overall costs. Additionally, Onwudike (1986) recommends that 15% FPKM can be safely included in broiler feed. The use of cellulolytic organisms to break down fibres in PKM has gained attention recently, offering a cost-effective alternative to soybean and corn-based feeds while maintaining performance (Chukwukaelo et al., 2018; Azizi et al., 2021).

Research on the use of palm kernel meals in broiler diets has yielded mixed results. Shakila (2012) reported that reducing palm kernel meal costs by 7.5% improved feed cost per kg of live weight gain, while Shahidan (2020) observed a decline in growth performance with higher inclusion rates. Bt (2014) found that palm kernel meal could replace up to 10% of maize without compromising growth or carcass quality. These studies indicate that palm kernel meal can be beneficial, particularly when combined with enzymes, but further research is needed to determine optimal inclusion levels.

Hematological parameters serve as key indicators of broiler health. As highlighted by Sundu et al. (2006), PKM benefits include enhanced bird immunity and improved gut health. Our study demonstrates an increase in red blood cells (RBCs) and haemoglobin (Hb) levels in broilers fed FPKM compared to those fed raw PKM, with no significant effect on white blood cell (WBC) count. The observed RBC range (3.17 to 3.49 x 10^12/L) aligns with reference ranges (Sulabo et al., 2013), while WBC counts remained stable (Yang et al., 2009). Enzyme-treated palm kernel expeller diets have been shown to improve energy utilisation and growth, correlating with higher haemoglobin levels (Saenphoom et al., 2013). This suggests that enhanced energy metabolism may positively impact hematological parameters. The findings are supported by Wattanakul et al. (2021), who also observed improved Hb levels in broilers fed FPKM diets.

Biochemical indices are essential for assessing the nutritional and physiological status of broilers. Environmental quality is more critical than stocking density in influencing broiler health (Thaxton et al., 2006). Our study found that total protein, globulin, and glucose levels significantly improved in broilers fed FPKM compared to those fed raw PKM, while albumin, HDL, and LDL levels remained unaffected. Muangkeow (2013) and Fasuyi (2019) also reported improvements in these indices with FPKM inclusion. However, other studies found no significant effect on blood albumin levels with different dietary components (Bello et al., 2011; Khadijat et al., 2012).

CONCLUSIONS

This study demonstrates that incorporating up to 15% Fermented Palm Kernel Meal (FPKM) in the diets of broiler chickens can significantly enhance growth performance, as evidenced by improved live body weight (LBW), feed intake (FI), and feed conversion ratio (FCR). Additionally, FPKM positively influences hematological parameters, notably increasing red blood cells (RBCs) and hemoglobin (Hb) levels, while maintaining stable white blood cell (WBC) counts. Biochemical analysis further supports the benefits of FPKM, showing significant improvements in total protein (TP), globulin (GLB), and glucose (GLU) levels, alongside a reduction in cholesterol levels. Importantly, the inclusion of FPKM does not adversely affect LDL, HDL, or albumin levels. Therefore, FPKM is a viable dietary component for broiler chickens, promoting better growth and health without negative impacts on hematological or biochemical indices.

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